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Standard Specification for
CLAY DRAIN TILE[1]

This Standard is issued under the fixed designation C 4; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval.

1. Scope

1.1 This specification covers drain tile made from clay, shale, fire clay, or mixtures thereof, and burned. In this specification, the term drain tile or tile shall mean tile made only from these materials.

2. Classes

2.1 Three classes of drain tile are covered:

2.1.1 Standard drain tile,

2.1.2 Extra-quality drain tile, and

2.1.3 Heavy-duty drain tile

2.2 Unless otherwise specified by the purchaser, heavy-duty or extra-quality drain tile shall be accepted instead of standard drain tile, and heavy-duty drain tile instead of extra-quality. Standard drain tile may be furnished and shall be considered as meeting this specification unless another class is specified by the purchaser.

3. Physical Requirements

3.1 Drain tile shall conform to the physical requirements for the class specified as prescribed in Table 1.

3.2 *Waiver of Absorption Requirements*—Requirements prescribed in Table 1 for water absorption (5-h boiling) shall be waived provided a sample consisting of five drain tile, meeting all other requirements, shows no disintegration or spalling and no loss in dry weight of any individual tile greater than 5 percent when subjected to the freezing and thawing test, made as prescribed in Sections 16 and 17. The number of cycles of freezing and thawing to which each class of tile shall be subjected are:

Class	Number of Cycles
Standard	36
Extra-quality	48
Heavy-duty	48

If tile meet the requirements of the freezing and thawing test, the average percentage absorption of the specimens used in the test shall be adopted as the maximum allowable average absorption for the contract in question. At least 80 percent of all tile tested shall meet the requirements prescribed in 3.2.

4. Sizes

4.1 Sizes of drain tile shall be designated by their inside diameters.

4.2 Drain tile smaller than 12 in. (304 mm) in diameter shall have a nominal length of not less than approximately 12 in. Tile 12 to 30 in. (304 to 762 mm) in diameter, inclusive, shall have nominal lengths not less than their diameters. Tile larger than 30 in. in diameter shall have a nominal length of not less than 30 in.

5. Materials, Workmanship, and Finish

5.1 Presence in drain tile of any minerals or chemicals that are known to cause slaking or disintegration of the tile shall be deemed valid grounds for rejection, unless satisfactory proof is submitted that the tile are durable and permanent.

5.2 Drain tile shall be free of cracks, checks, or chips extending into the body of the tile in such a manner as would decrease the strength appreciably. There shall be no breaks in the tile that would admit earth into the drain.

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5.3 Drain tile shall be reasonably smooth on the inside and shall be approximately circular in cross section, except when otherwise specified in advance. They shall be approximately straight, except in the case of special connections. The ends of butt-end tile shall be so regular and smooth as to make possible close joints by turning and pressing together the ends of adjoining tile. Butt-end tile shall be furnished unless otherwise specified by the purchaser.

5.4 Drain tile shall conform to the general physical characteristics prescribed in Table 2.

6. Inspection and Rejection

6.1 All drain tile shall be given a thorough inspection by a competent inspector approved by the purchaser. The tile shall be inspected at a location and time agreed upon by the purchaser and seller. The purposes of the inspection shall be to: (*1*) cull and reject imperfect individual tile, and (*2*) determine whether the tile, by visual inspection, meet the requirements set forth in Sections 5 and 6.

6.2 Drain tile in a dry condition shall give a clear ring when held free of the ground or tipped on edge, and tapped lightly with a hammer that has a head not exceeding 4 oz (113 g) in weight.

6.3 The seller may appeal from decisions of the inspector when such decisions are based on visual inspection alone, in which case the point of issue shall be determined by standard physical tests made in accordance with Sections 9 to 18. Costs of such tests based on an appeal shall be paid by the seller if the tests confirm the inspector's decision; otherwise, these costs shall be paid by the purchaser.

6.4 The inspector shall plainly mark all rejected drain tile, which shall be removed promptly by the seller at the expense of the seller.

6.5 No drain tile shall be rejected by the purchaser on the basis of physical tests unless the laboratory test report is made available to the seller.

7. Sampling and Testing

7.1 Tile shall be sampled and tested in accordance with Sections 9 to 18.

7.2 For purposes of the test, full-size, unbroken drain tile shall be selected by the purchaser or by his authorized representative. Specimens shall be representative of the whole lot of tile from which they are selected, after culling undesirable tile which fail to meet visual inspection requirements. The place or places of selection shall be designated when the purchase order is issued. The manufacturer or seller shall furnish specimens for test without charge.

7.3 Each specimen shall be so marked that it may be identified at any time.

7.4 Unless otherwise specified in the purchase order, costs of tests shall be paid as follows:

7.4.1 If results of tests show that tile do not conform to the requirements of this specification, the cost shall be paid by the seller.

7.4.2 If results of tests show that tile do conform to requirements of this specification, the cost shall be paid by the purchaser, except that in the case of the freezing and thawing test, when specifically requested by the seller in order to justify waiver of absorption requirements, the cost of tests shall be paid by the seller.

7.4.3 Should the standard sample of tile selected as prescribed in 7.1 fail to conform to physical requirements prescribed in Section 3, the seller may, at his expense, cull the tile and have other tile selected for retest from the remaining stock. Selection of specimens for the purpose of retest shall be made as prescribed in 7.1 and 7.2, except that the number of tile sampled shall be ten per standard physical test. If the tile selected fail to meet the requirements in the retest, the lot may be rejected by the purchaser as not meeting this specification. The seller shall pay all costs for any retesting he demands.

8. Basis of Acceptance

8.1 Acceptability of the tile shall be determined by (*1*) measurements and visual inspection as prescribed in Sections 6 and 7, and (*2*) compliance with the physical requirements as prescribed in Section 3.

8.2 Acceptance of drain tile as satisfactorily meeting one of the two general requirements in 8.1 shall in no way be construed as a waiver of the other.

TEST METHODS

Crushing Strength Tests

9. Test Specimens

9.1 Test five unbroken, full-size drain tile of each specified size.

9.2 Immerse drain tile with nominal inside diameter of 12 in. (304 mm) or less in water for at least 1 h and not more than 2 h immediately prior to testing. Tile with nominal inside diameters greater than 12 in. may be tested without wetting but shall not be dried except as may occur in complying with the provisions in 9.3.

9.3 Do not expose any specimen of tile to water or air temperature lower than 40 F (4.4 C) from the beginning of wetting until tested. Completely thaw frozen tile before being tested.

10. Apparatus

10.1 The loading device may consist of any mechanically driven or hand-powered device that meets the following requirements:

10.1.1 It shall be substantially built and rigid throughout so that distribution of load to the specimen will not be affected appreciably by deformation or yielding of any part.

10.1.2 It shall provide for continuous application of load at a uniform rate—from 500 to 2000 lbf/lineal ft·min (7300 to 29 000 N/lineal m·min).

10.1.3 It shall provide means for determination of load with an error not greater than 2 percent.

11. Procedure

11.1 Make strength tests by the three-edge-bearing method.

11.2 Accurately center all bearings and specimens of tile to secure a symmetrical distribution of loading on each side of the center of tile in every direction.

11.3 Apply load as nearly continuously as testing equipment permits until the specimen fails.

11.4 The lower bearing for the tile shall consist of two wooden strips free of knots and with vertical sides, having their interior top corners rounded to a radius of approximately ½ in. (12.7 mm) (see Fig. 1). The strips shall be straight, and shall be securely fastened to a rigid base with the interior vertical sides parallel and spaced a distance apart not less than ½ in., nor more than 1 in./ft (42 to 83 mm/m) of the nominal tile diameter, with a minimum spacing of 1 in. Make sure the upper bearing is straight and true from end to end and apply the load through a wood beam or wooden-faced metal beam of such dimensions that it will transmit the full load without appreciable deflection. Upper and lower bearings shall extend the full length of tile exclusive of the bell, if any. Symmetrically place tile between the two bearings, and center the application of load at the center of the length of tile. In testing a tile that is "out of straight," choose the lines of bearing which appear to give the most favorable conditions for a fair test.

11.5 Plaster of paris bedding fillets may be used on the upper and lower bearings, if mutually agreed by the manufacturer, or other seller, and the purchaser. Before the tile is placed, cast a fillet of plaster of paris thick enough to compensate for inequalities in the tile barrel on and between the lower bearings and place the tile in position on the fillet while the plaster is still somewhat plastic.

11.6 Cast a similar fillet along the length of the crown of the tile. This fillet shall have a width equal to that of the upper bearing block and, for this test, the upper bearing block shall have a width 1 in. (25.4 mm) greater than the distance between the strips constituting the lower bearing.

11.7 If mutually agreed by the manufacturer, or other seller, and the purchaser, proven types of bearings such as hard rubber or sand-filled high-pressure hose may be used instead of wooden bearings as specified in 11.4.

12. Calculations and Report

12.1 Report results of strength tests in pounds-force per lineal foot (or newtons per lineal metre) of tile. Report separately for each of the tile constituting a standard test, together with the average.

Absorption Test

13. Test Specimens

13.1 Test specimens shall consist of segments taken from each of the five tile broken in the strength test and shall be selected in accordance with the following provisions:

13.1.1 For tile with nominal inside diameters of 12 in. (304 mm) or less, and nominal lengths of 12 in., a "standard sample" shall consist of one full-length quarter segment taken from each of the five tile broken in the strength test. By quarter segment is meant one of the four pieces into which a tile usually breaks in the strength test. The segment selected shall have approximately uniform width. If a tile breaks in such a manner that a satisfactory quarter segment cannot be obtained, the absorption test may be made on two or more pieces whose combined areas approximate the area of a quarter tile of that size, selected so that both ends and center portion of the tile are represented. The average absorption of the pieces so selected shall be considered to be the absorption for that tile.

13.1.2 For tile with nominal inside diameters or lengths in excess of 12 in. (304 mm) the absorption test shall be made on three pieces, one piece taken from one end of the tile, another piece taken from the opposite end, and the third piece from near the center. Specimens shall have the full thickness of the tile, with all edges broken, or cut, preferably from tile broken in the strength test. Each specimen shall have an area not less than 25 in.^{2} (161 cm^2) as measured on one barrel surface. Average absorption of the three pieces shall be considered to be the absorption for that tile.

13.1.3 All absorption test specimens shall be apparently sound, solid pieces of tile, shall not show cracks or badly shattered edges, and shall have laminations and fissures only to the extent that these are representative of the tile from which they are taken.

14. Procedure

14.1 *Drying*—Dry specimens at least 16 h in a ventilated oven at a temperature between 230 and 248 F (110 and 120 C) and until two successive weighings at intervals of not less than 3 h show an increment of loss not greater than 0.1 percent of the original weight of the specimen. Dry weights of specimens shall be the weights after final drying, and as soon as the specimen has cooled to 75 ± 10 F (24 ± 5.5 C). The balance used shall be sensitive to 0.5 g when loaded with 1 kg, and weighings shall be read to at least the nearest gram. Where other than metric weights are used, the same order of accuracy must be obtained.

14.2 *Saturation*—Place dried specimens in a suitable container, pack tightly enough to prevent jostling, and cover with clean water. Heat water to boiling in not less than 1 nor more than 2 h, boil continuously for 5 h, and then allow to cool to room temperature by natural loss of heat for not less than 12 h. Remove specimens from the water and allow to drain for not more than 1 min. Remove superficial water by absorbent cloth or paper, and immediately weigh the specimens.

15. Calculations and Report

15.1 Calculate absorption as a percentage of initial dry weight (see 14.1), carried to the nearest 0.1 percent. Report results separately for each specimen, together with the average for all specimens comprising the standard sample.

Freezing and Thawing Test

16. Test Specimens

16.1 Test specimens for the freezing and thawing test shall be in the range of absorption values that required such a test and shall be selected by one of the following methods:

16.1.1 Specimens may be from the original tile samples used in crushing tests but not subjected to boiling, or

16.1.2 The manufacturer shall assist in selecting a group of five tile in the absorption range at which it is desired to establish a waiver of the absorption test. However, the absorption of each test specimen shall be equal to or greater than the average absorption at which the tile failed to meet absorption requirements as shown in Table 1.

16.1.3 Two sets of test specimens shall be prepared from each of the tile selected. The size and number of test specimens shall be as prescribed in 13.1 and 13.2. One set shall be used for determining absorption in accordance with 14.1 and 14.2, and the remaining set, for freezing and thawing test in accordance with Section 17.

17. Procedure

17.1 *Drying and Saturation*—Dry specimens in accordance with Section 14.1. Saturate specimens by submersion in water at room temperature of 70 ± 30 F (21 ± 17 C) for not less than 24 h. Use the same scales and weights specified in Section 14 for the absorption test, or others of equal sensitivity and accuracy, for weighings required in the freezing and thawing test.

17.2 *Freezing and Thawing*—When the specimens have been weighed at the conclusion of saturation, return them to water and keep them immersed until the freezing test is begun. For freezing, place specimens with their concave faces upward in water-tight trays. Adjust depth of water in each tray to ½ in. (12.7 mm) and place the trays in the freezing apparatus. Perform freezing in an atmosphere in which the natural or artificial air currents are no greater than necessary to maintain approximately uniform temperatures in all parts of the freezing compartment. The freezing apparatus shall have sufficient heat-absorbent capacity for lowering the temperature of the freezing compartment to +14 F (−10 C) within 30 min after introduction of the specimens and for maintaining a temperature of +4 ± 10 F (−15.5 ± 5.5 C). Each freezing period shall be not less than 3 h for specimens from tile with walls up to 1.5 in. (38.1 mm) thick, and 4 h for specimens with walls more than 1.5 in. thick. Remove trays containing the specimens and submerge in water at a temperature of 75 ± 10 F (24 ± 5.5 C). The tank in which the specimens are thawed should contain sufficient water to maintain water temperature at 70 ± 15 F (21 ± 8.5 C) while the specimens are thawing. In order that this condition may prevail, use running water or moderately heat the water in the tank for at least 1 h until all the ice has melted. Place the trays of specimens in the freezer as before and continue the freezings and thawings until the number of cycles required is completed.

18. Calculations and Report

18.1 At the end of the thawing treatment, inspect specimens and note the condition of each in the records. When the number of cycles specified has been completed, oven-dry the specimens and weigh as specified in 17.1 and compute the loss in weight as a percentage of the initial dry weight. Report the number of cycles required to cause breakage, if breakage occurs. Where the specimen has not failed by breakage, report the percentage loss in weight at the conclusion of 36 and 48 cycles.

TABLE 1 Physical Test Requirements for Clay Drain Tile

Internal Diameter of Tile, in.	Standard Drain Tile				Extra-Quality Drain Tile				Heavy-Duty Drain Tile			
	Minimum Crushing Strength,[a] lb/lin ft (kN/m)		Maximum Water Absorption by 5-h Boiling,[b] percent		Minimum Crushing Strength,[a] lb/lin ft (kN/m)		Maximum Water Absorption by 5-h Boiling,[b] percent		Minimum Crushing Strength,[a] lb/lin ft (kN/m)		Maximum Water Absorption by 5-h Boiling,[b] percent	
	Average of Five Tile	Individual	Average of Five Tile	Individual	Average of Five Tile	Individual	Average of Five Tile	Individual	Average of Five Tile	Individual	Average of Five Tile	Individual
4	800 (11.7)	680 (9.9)	13	16	1100 (16.0)	990 (14.4)	11	13	1400 (20.4)	1260 (18.4)	11	13
5	800 (11.7)	680 (9.9)	13	16	1100 (16.0)	990 (14.4)	11	13	1400 (20.4)	1260 (18.4)	11	13
6	800 (11.7)	680 (9.9)	13	16	1100 (16.0)	990 (14.4)	11	13	1400 (20.4)	1260 (18.4)	11	13
8	800 (11.7)	680 (9.9)	13	16	1100 (16.0)	990 (14.4)	11	13	1500 (21.8)	1350 (19.7)	11	13
10	800 (11.7)	680 (9.9)	13	16	1100 (16.0)	990 (14.4)	11	13	1550 (22.6)	1400 (20.4)	11	13
12	800 (11.7)	680 (9.9)	13	16	1100 (16.0)	990 (14.4)	11	13	1700 (24.8)	1530 (22.3)	11	13
14	840 (12.3)	720 (10.5)	13	16	1100 (16.0)	990 (14.4)	11	13	1850 (27.0)	1660 (24.2)	11	13
15	870 (12.7)	740 (10.8)	13	16	1150 (16.7)	1030 (15.0)	11	13	1980 (28.9)	1780 (26.0)	11	13
16	... ...	... ...	...	...	1200 (17.5)	1080 (15.7)	11	13	2100 (30.6)	1890 (27.6)	11	13
18	... ...	... ...	...	...	1300 (19.0)	1170 (17.0)	11	13	2340 (34.1)	2110 (30.8)	11	13
21	... ...	... ...	...	...	1450 (21.1)	1300 (19.0)	11	13	2680 (39.1)	2410 (35.2)	11	13
24	... ...	... ...	...	...	1600 (23.3)	1440 (21.0)	11	13	3000 (43.8)	2700 (39.4)	11	13
27	... ...	... ...	...	...	1800 (26.2)	1620 (23.6)	11	13	3330 (48.6)	3000 (43.8)	11	13
30	... ...	... ...	...	...	2000 (29.1)	1800 (26.2)	11	13	3590 (52.4)	3230 (47.1)	11	13

[a] Strengths of sizes not listed may be interpolated between tabular values of sizes and strengths of the nearest listed diameters.

[b] In case tile fails to meet absorption requirements, see 3.2.

TABLE 2 Distinctive General Physical Properties of Clay Drain Tile

Physical Properties Specified	Standard Drain Tile	Extra-Quality Drain Tile	Heavy-Duty Drain Tile
Permissible variation of average diameter below specified diameter, percent	3	3	3
Permissible variations between maximum and minimum diameters of same tile, percentage of thickness of wall	75	65	65
Permissible variation of average length below manufacturer's specified length, percent	3	3	3
Permissible variation from straightness, percentage of length	3	3	3
Permissible thickness of exterior blisters, lumps, and flakes which do not weaken tile and are few in number, percentage of thickness of wall	20	15	15
Permissible diameters of above blisters, lumps, and flakes, percentage of inside diameter	15	10	10
General inspection	rigid	very rigid	very rigid

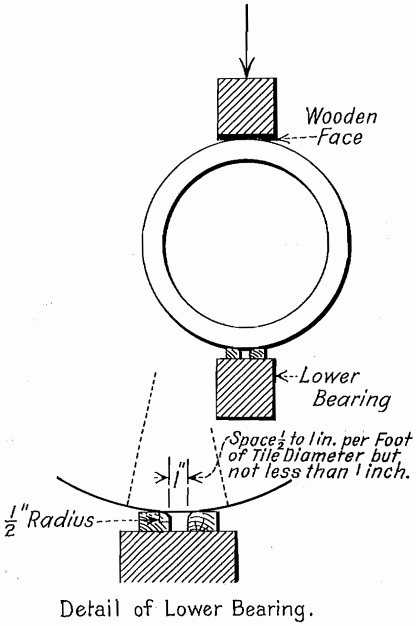
Wooden Face
Lower Bearing
Space ½ to 1 in. per Foot of Tile Diameter but not less than 1 inch.
1"
½" Radius
Detail of Lower Bearing.

FIG. 1 Three-Edge Bearings.

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